

WinDS-H2 Model and Analysis

2004 DOE Hydrogen, Fuel Cells & Infrastructure
Technologies Program Review

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May 25, 2004

This presentation does not contain any proprietary or confidential information.



Project Objectives

- Identify the scenarios, time frames and regions of the U.S. in which wind turbines that generate both electricity and hydrogen are likely to become economical
- From a market perspective, optimize wind system concepts that produce both electricity and hydrogen, both today and in the future

Budget

- Funded as a part of the NREL Hydrogen Analysis task
- Total FY04 Funding: \$230 K

Technical Barriers and Targets

- Hydrogen Generation by Water Electrolysis
 - Barriers
 - T. Renewable Integration
- Targets
 - Verify renewable integrated electrolytic hydrogen production at \$2.50/kg

Approach

- Add hydrogen production from wind to NREL's WinDS model
 - WinDS-H2 is a multi-regional, multi-time-period model of capacity expansion in the electric sector and H2 production from wind in the U.S.
- Evaluate the market potential for hydrogen from wind under different scenarios using WinDS-H2

Project Safety

- Inasmuch as this project is a computer-based analysis effort, there are no safety issues

Project Timeline

FY Quarter	1	2	3	4
Milestone	1	2	3	4

Project started in June 2003

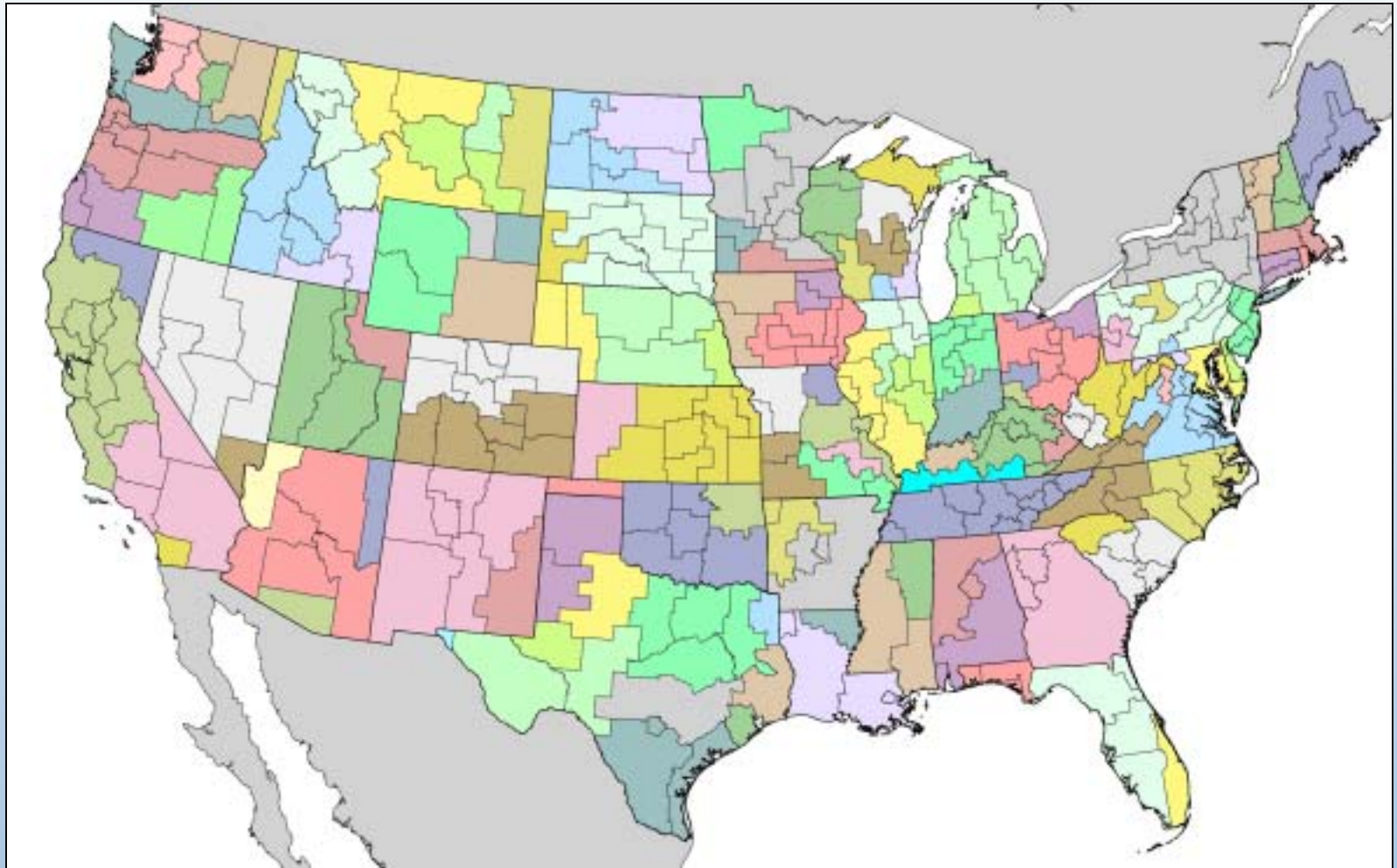
Milestones/Deliverables (* completed):

- 1) Base case analysis report *
- 2) Report on the addition of steam methane reforming to WinDS-H2*
- 3) Report on the addition of other renewable technologies to WinDS-H2
- 4) Summary of analysis to answer project questions for wind/H2 analysis

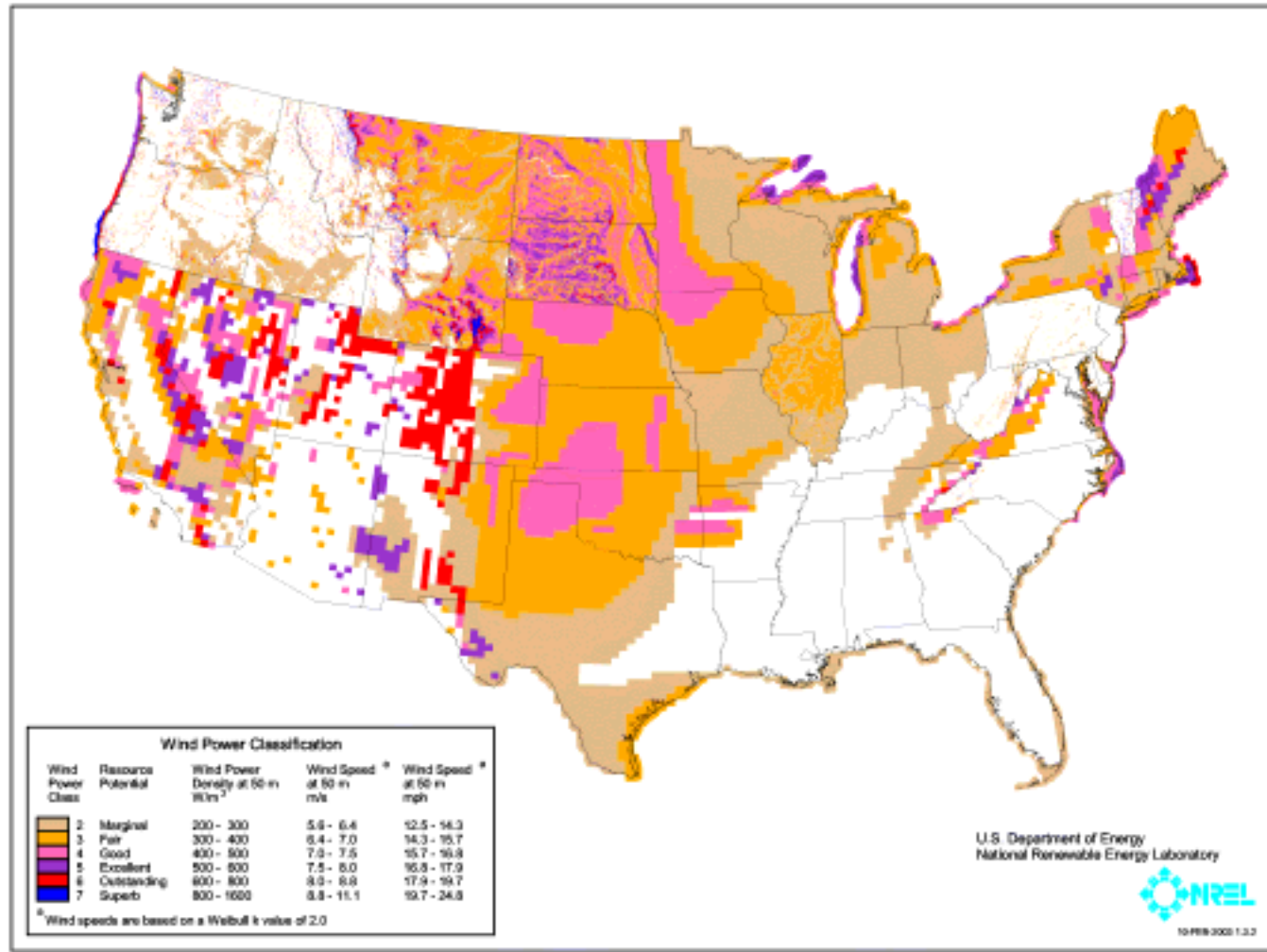
Accomplishments

- WinDS-H2 Model: A brief description
- Base Case results
- A sensitivity case

WinDS Regions

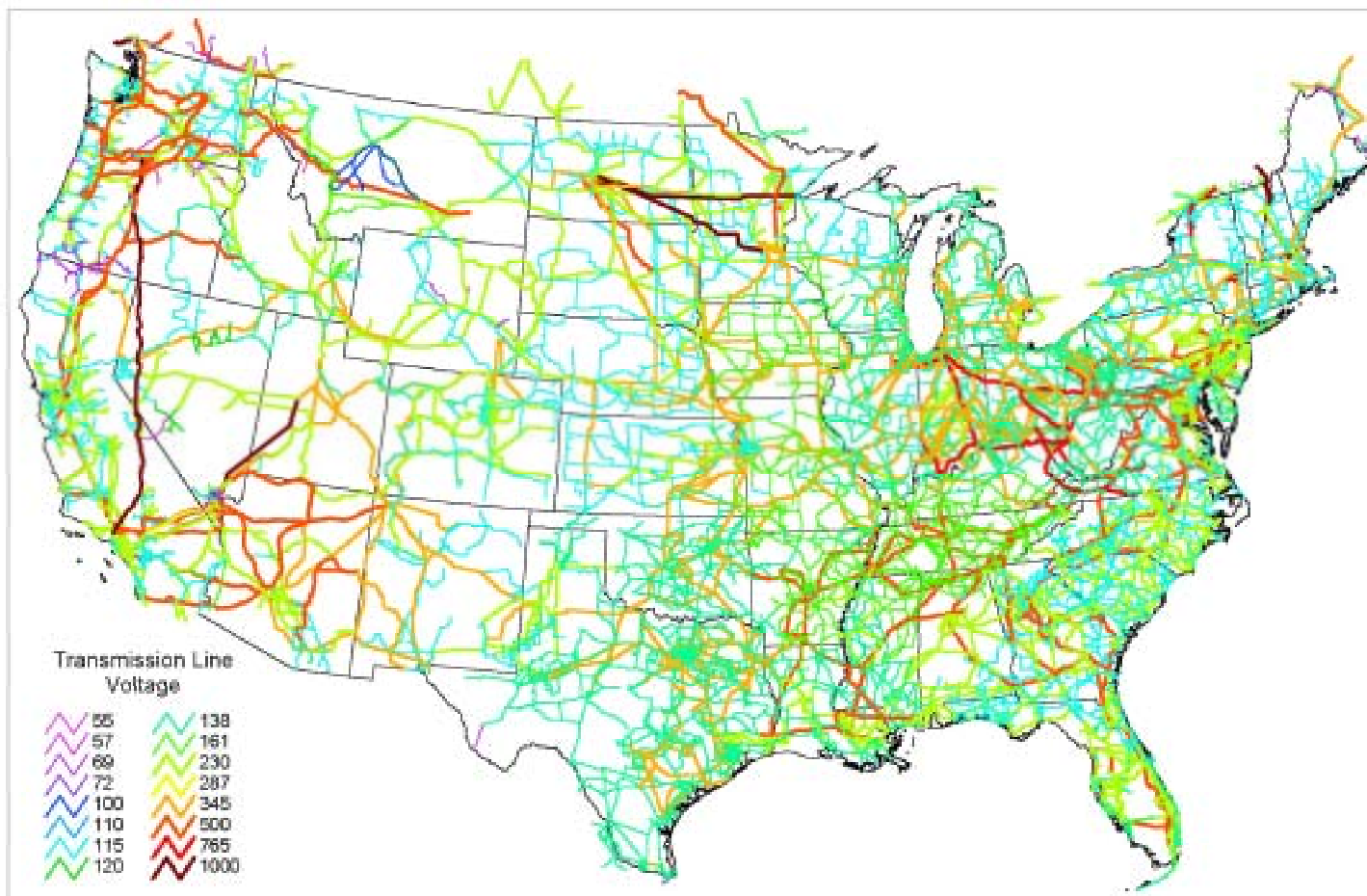


Wind Resources

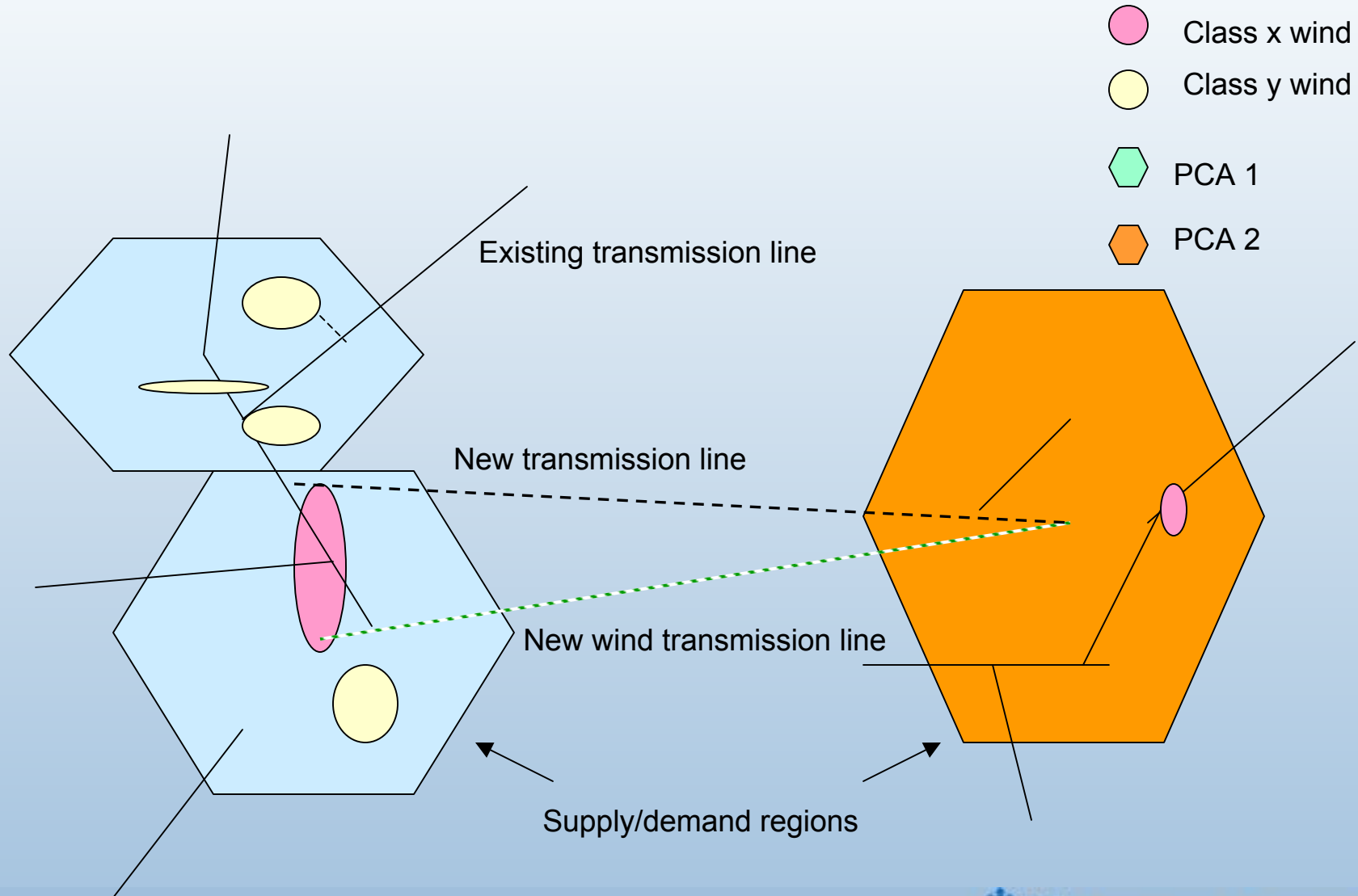


Transmission in WinDS

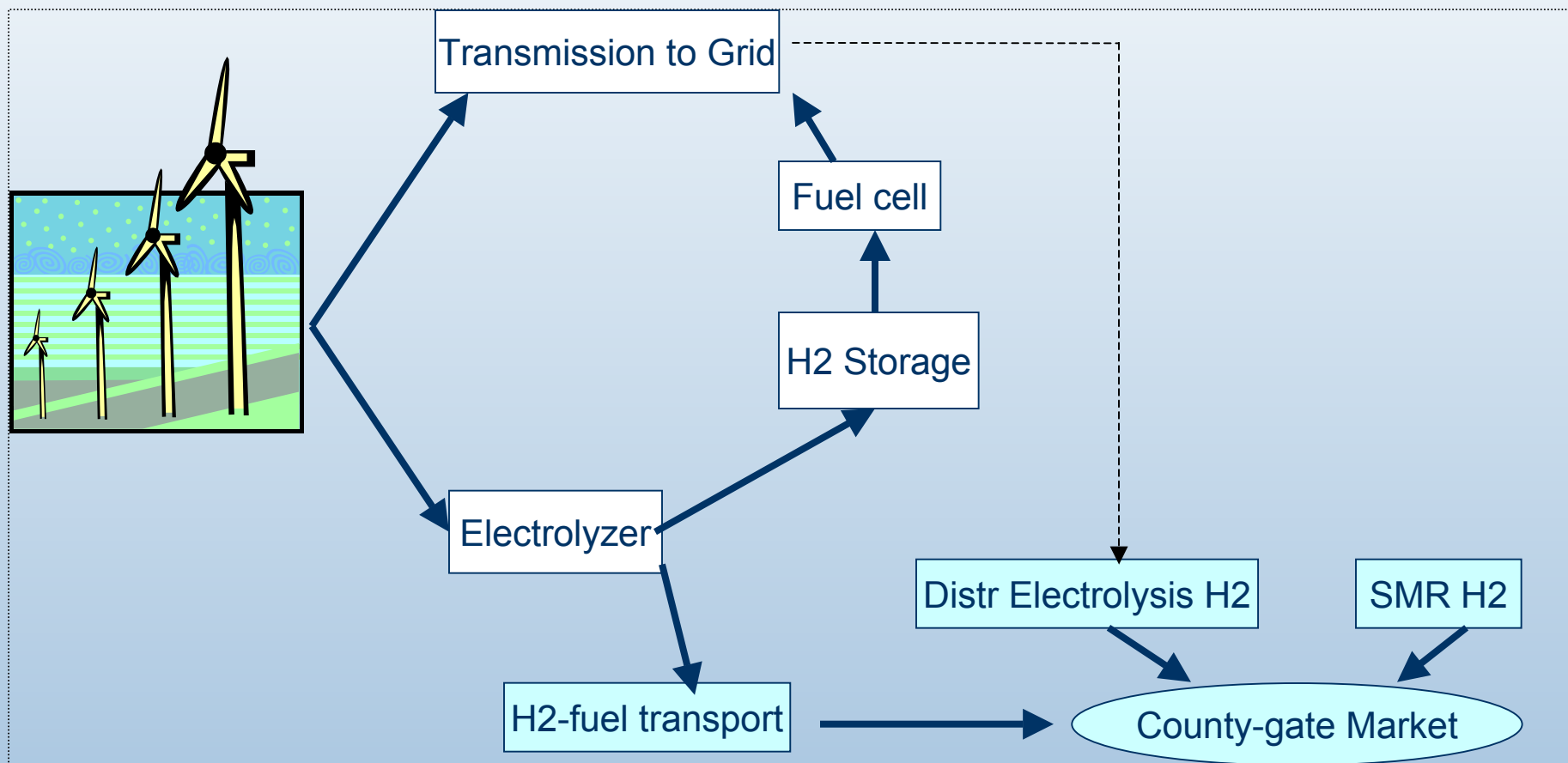
Transmission Lines by Voltage



Constraints on Wind Transmission



Hydrogen in WinDS-H2



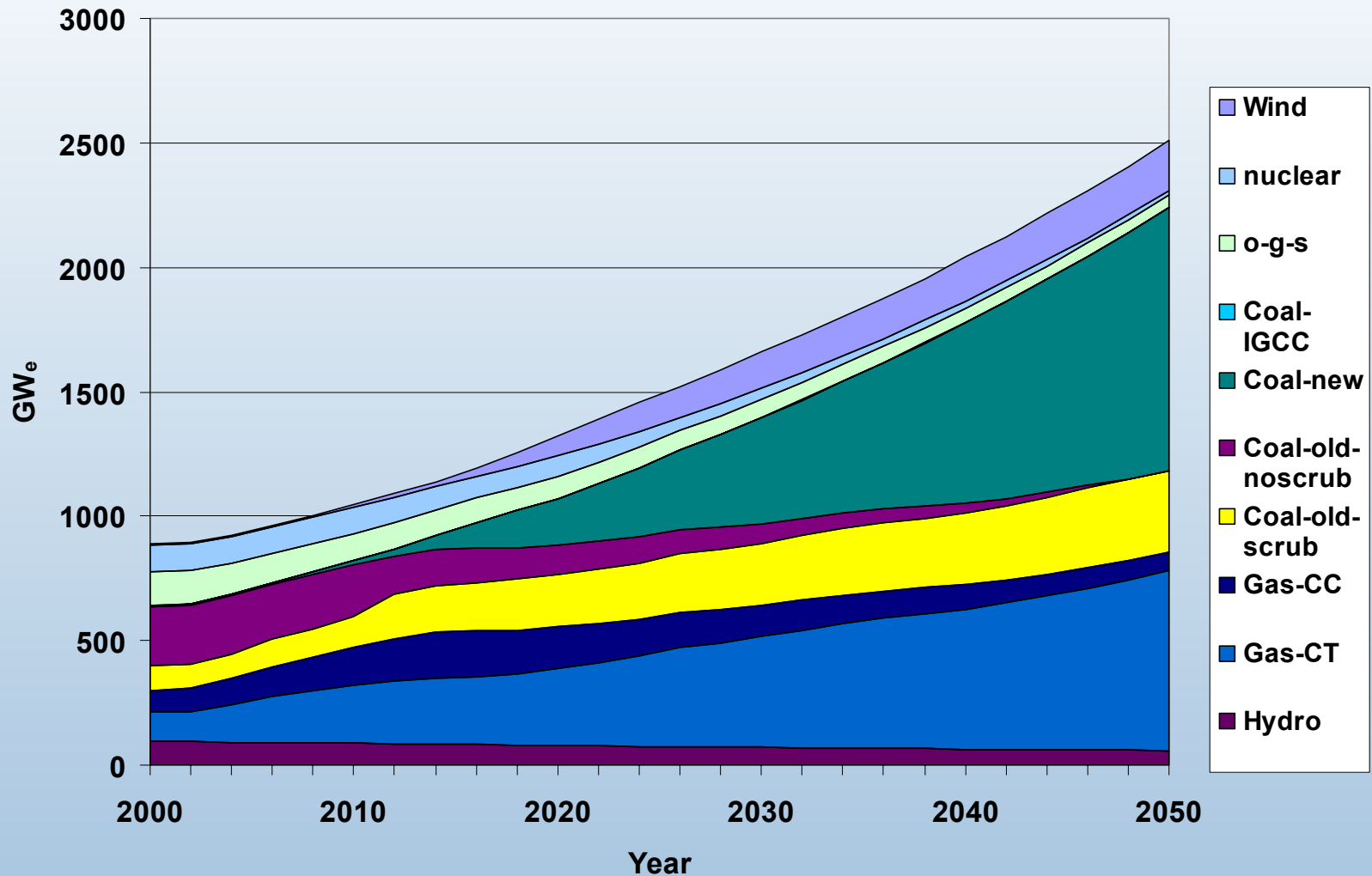
Cost/Performance for Class 6 Wind Resources

Year	Capital Cost (\$/kW)	Capacity Factor
2000	942	0.4
2010	754	0.5
2020	706	0.54

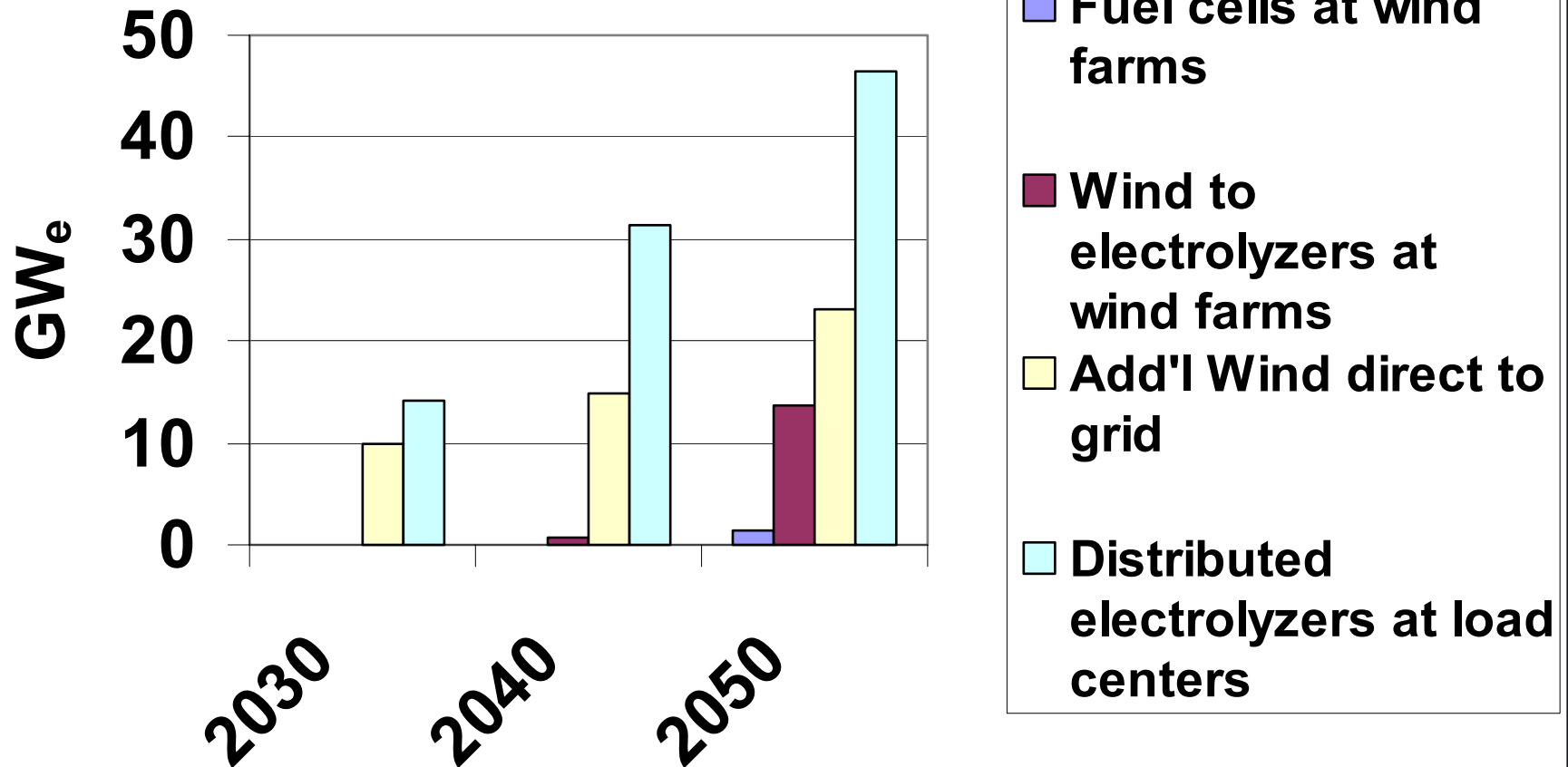
2010 H2 Technologies Cost/Performance Scenario

Technology	Capital Cost	Efficiency %
Electrolyzer	\$150/kWe	80
Fuel Cell	\$400/kWe	50
Steam Methane Reformer	\$4/kg-yr	70

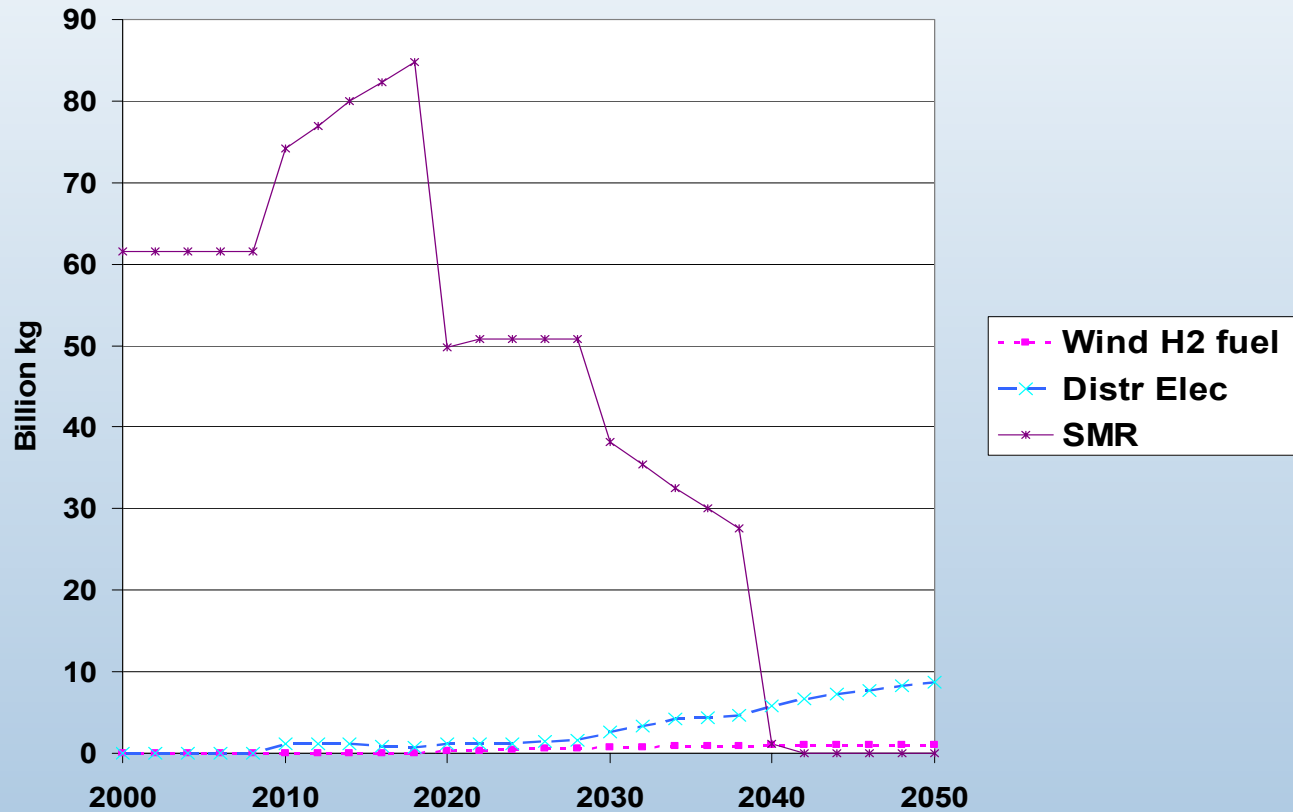
Base Case Results



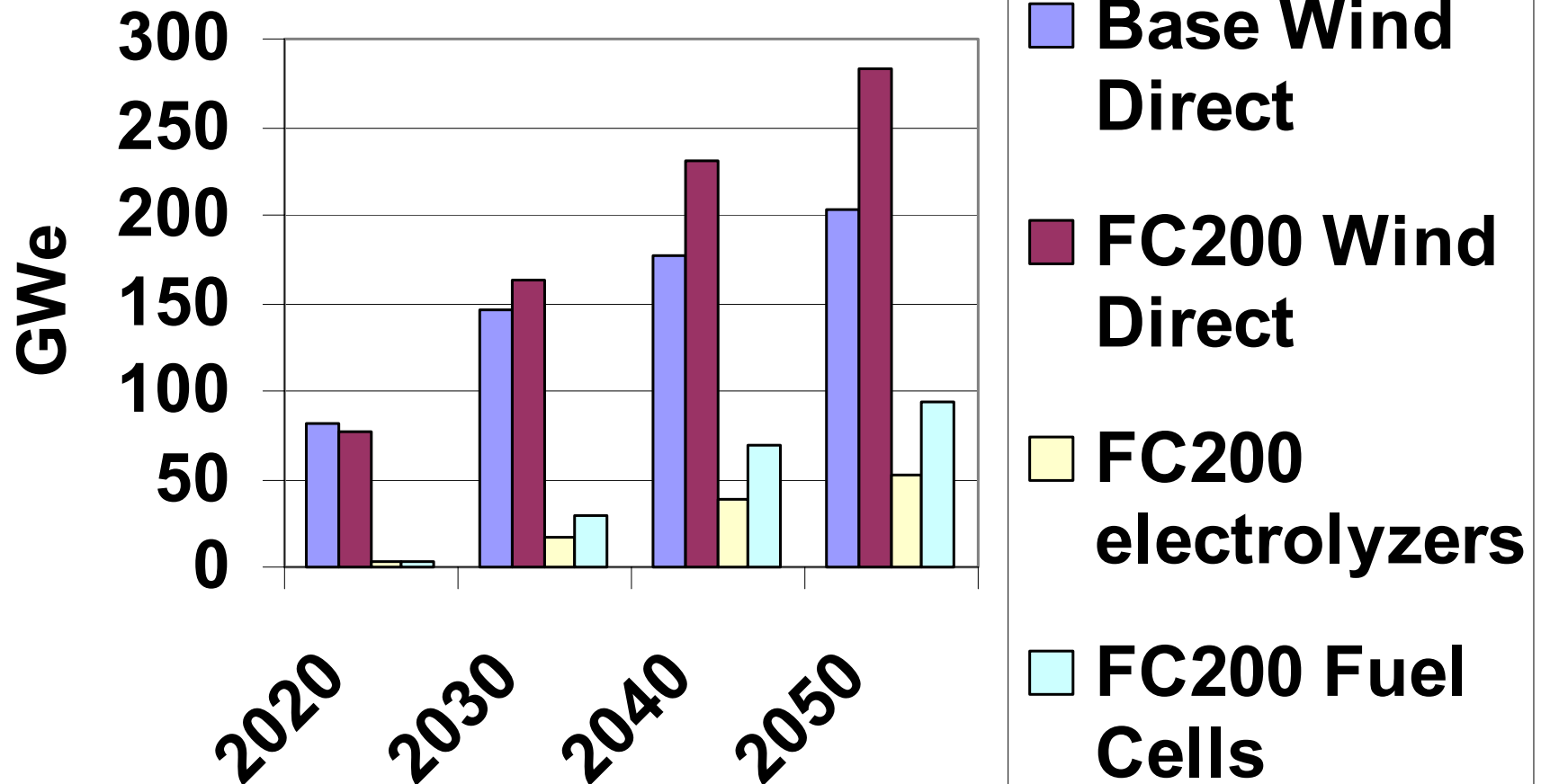
Capacities in the Base Case



Hydrogen Production in the Base Case



A Sensitivity Case: Reduced Fuel Cell Costs



Conclusions

- The use of electrolyzers and fuel cells at wind sites to store/shift wind generation from off-peak to on-peak periods is unlikely due to round-trip efficiencies and costs.
- Where wind resources are close to transportation fuel demand centers, electrolyzers at wind farms may be preferred to electrolyzers distributed close to the demand center.
- Wind's most substantial contribution may be as power to the grid needed for the additional demand for power required by distributed electrolyzers.

Interactions and Collaborations

- Interaction with DOE and NREL Hydrogen Programs Analysis staff for hydrogen system configuration and data inputs.
 - Mark Paster
 - Maggie Mann
 - Johanna Ivy
- Interaction with NREL Wind Program staff for wind system costs
 - Alan Laxson
 - Lee Jay Fingersh

Responses to Previous Year's Comments

- This is a new project
- There has been no prior review

Future Work

- Complete FY2004 deliverables
 - Add biomass as a source of H₂
 - Document methodology and analyses
- Assess different scenarios of markets and costs
- Continue to refine model and data inputs